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# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 02 01 608 285	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/DK 03/00701	International filing date (day/month/year) 14.10.2003	Priority date (day/month/year) 15.10.2002
International Patent Classification (IPC) or both national classification and IPC G01M19/00		
Applicant DANFOSS AS et al.		

- This International preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 5 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
 These annexes consist of a total of 6 sheets.

- This report contains indications relating to the following items:
  - ☒ Basis of the opinion
  - ☐ Priority
  - ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
  - ☐ Lack of unity of invention
  - ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - ☐ Certain documents cited
  - ☐ Certain defects in the international application
  - ☐ Certain observations on the international application

Date of submission of the demand  06.05.2004	Date of completion of this report  04.02.2005
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Köck, A  Telephone No. +49 89 2399-2493  

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/DK 03/00701**

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

1-21 as originally filed

**Claims, Numbers**

2-8, 10-15 received on 10.05.2004 with letter of 06.05.2004

1, 9 received on 20.01.2005 with letter of 20.01.2005

**Drawings, Sheets**

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY  
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International application No. **PCT/DK 03/00701**

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims	1,9
	No: Claims	
Inventive step (IS)	Yes: Claims	2-8,10-15
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-15
	No: Claims	

**2. Citations and explanations**

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/DK 03/00701

V. Reasoned statement under Article 35(2) PCT

1. The following documents have been considered for the purposes of this report:

D1 = US-A-5 615 733

D2 = US-A-3 918 300

D3 = EP-A-0 155 826

2. Article 33(2) (novelty)

A method of detecting an abnormality of a heat exchanger is known from D1 (col. 1, L. 6 - 11; Fig. 1), exchanging heat between a first fluid flowing in a conduit (1) and a second fluid flowing along a flow path (10), said conduit (1) and said flow path (10) each having an inlet (13,11) and an outlet (14,12), establishing at least one parameter representative of the temperature condition of the heat exchanger (T1 - T4),

establishing a second fluid inlet temperature (T3),

establishing a parameter indicative of expected heat exchange between the heat exchanger and the second fluid (by microprocessor (5)),

processing the at least one parameter, the second fluid inlet temperature and the parameter of expected heat exchange for establishing the second fluid outlet temperature (in microprocessor (5)),

employing the second fluid outlet temperature for evaluating the heat exchange between first and second fluids by comparing the second fluid outlet temperature with a reference value (comparing T3 with T4).

Furthermore, the features of the second part of claim 1 are known from D1: The second fluid outlet temperature is established from a parameter representative of the temperature conditions of the heat exchanger, namely from the temperature T4.

The present application does thus not satisfy the criterion set forth in Article 33(2) PCT because the subject-matter of claim 1 and corresponding apparatus claim 9 is not new in respect of prior art as defined in the regulations (Rule 64(1)-(3) PCT).

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/DK 03/00701

3. Article 33(3) PCT (inventive step)

The dependent claims are merely simple and routine features that the skilled man would include in an information display system, their subject-matter thus lacking an inventive step, see D2, Fig. 4 and cl. 1 and D3, Fig. 1 and cl. 1.

4. Industrial applicability

The claimed device may be used to detect heat exchanger abnormalities in refrigerator systems.

5. The documents D1, D2 and D3 have not been identified in the description nor has the relevant background art disclosed therein been discussed. The requirements of Rule 5.1(a)(ii) PCT are, thus, not fulfilled.
6. The independent claims should have been drafted in the two-part form as required by Rule 6.3(b) PCT, whereby the features known from D1 should have been placed in the preamble.

## A M E N D E D   C L A I M S

1. A method for detecting an abnormality of a heat exchanger (3, 5) exchanging heat between a first fluid flow (7) flowing in a conduit (6) and a second fluid flow (8) flowing along a flow path (9), said conduit (6) and said flow path (9) each having an inlet and an outlet, said method comprising the steps of:

10        establishing at least one parameter representative of the temperature conditions of the heat exchanger (3, 5),

          establishing a second fluid inlet temperature,  
          establishing a parameter indicative of expected  
15    heat exchange between the heat exchanger and the second fluid,

          establishing an estimated second fluid outlet temperature, and

          employing the second estimated fluid outlet  
20    temperature for evaluating the heat exchange between the first and second fluids by comparing the estimated second fluid outlet temperature, or a parameter derived therefrom, with a reference value,

25    characterised in that the estimated second fluid outlet temperature is established from at least one parameter representative of the temperature conditions of the heat exchanger, the second fluid inlet temperature and the parameter being indicative  
30    of an expected heat exchange.

9. A heat exchanger abnormality detection device for a heat exchanger (3, 5) exchanging heat between a first fluid (7) in a conduit (6) and a  
35    second fluid (8) in a flow path (9), the device comprising a first estimator estimating at least one

parameter representative of the temperature conditions of the heat exchanger, a first intermediate memory means storing the at least one parameter representative of the temperature conditions of the heat exchanger, a temperature sensor measuring the second fluid inlet temperature, a second intermediate memory means storing the second fluid inlet temperature, a second estimator establishing a parameter indicative of expected heat exchange between the heat exchanger (3, 5) and the second fluid (8), a third intermediate memory means storing the parameter indicative of expected heat exchange, a processor establishing an estimated second fluid outlet temperature, and a comparator

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comparing the estimated second fluid outlet temperature, or a parameter established on basis thereof, with a reference value, characterised in that the estimated second fluid outlet temperature is based on said at least one parameter representative of the temperature conditions of the heat exchanger, said second fluid inlet temperature, from the first and second intermediate memory means, respectively, and the parameter indicative of expected heat exchange from the third intermediate memory means

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EPO - DG 1

10.05.2004

22

## C L A I M S

(97)

1. A method for detecting an abnormality of a heat exchanger (3, 5) exchanging heat between a first fluid flow (7) flowing in a conduit (6) and a second fluid flow (8) flowing along a flow path (9), said conduit (6) and said flow path (9) each having an inlet and an outlet, characterized in comprising the steps of:

establishing at least one parameter representative of the temperature conditions of the heat exchanger (3, 5),

establishing a second fluid inlet temperature, establishing a parameter indicative of expected heat exchange between the heat exchanger and the second fluid,

processing the at least one parameter representative of the temperature conditions of the heat exchanger, the second fluid inlet temperature and the parameter indicative of expected heat exchange for establishing an estimated second fluid outlet temperature,

employing the estimated second fluid outlet temperature for evaluating the heat exchange between the first and second fluids by comparing the estimated second fluid outlet temperature, or a parameter derived therefrom, with a reference value.

2. A method according to claim 1, characterized in the reference value is a predetermined second fluid outlet temperature.

3. A method according to claim 1, characterized in using the estimated second fluid outlet temperature for establishing a second heat rate of the second fluid for evaluating the energy balance of the second heat rate of the second fluid compared to a first heat rate of the first

REPLACEMENT SHEET

AMENDED SHEET

10-05-2004



fluid.

4. A method according to claim 3, characterized in establishing the second rate of heat flow of the second fluid by establishing an estimate of a second fluid mass flow and a specific enthalpy change of the second fluid across the heat exchanger based on the estimated second fluid outlet temperature and the second fluid inlet temperature, and the condensation pressure.

5. A method according to claim 3 or 4, characterized in establishing the first rate of heat flow by establishing a first fluid mass flow and a specific enthalpy change of the first fluid across the heat exchanger based on parameters representative for first fluid inlet and outlet temperatures.

6. A method according to any of the claims 3-5, characterized in establishing a residual as difference between the first heat rate and the second heat rate.

7. A method according to claim 2, characterized in establishing a residual as difference between the estimated and predetermined second fluid outlet temperature.

8. A method according to claim 6 or 7, characterized in providing an abnormality indicator by means of the residual, the abnormality indicator being provided according to the formula:

$$S_{\mu,j} = \begin{cases} S_{\mu,j-1} + s_j, & \text{when } S_{\mu,j-1} + s_{\mu,j} > 0 \\ 0, & \text{when } S_{\mu,j-1} + s_{\mu,j} \leq 0 \end{cases} \quad (20)$$

where  $s_{\mu,j}$  is calculated according to the following equation:

$$s_{\mu,j} = c_1 \left( r_j - \frac{\mu_0 + \mu}{2} \right) \quad (21)$$

REPLACEMENT SHEET

AMENDED SHEET

10-05-2004

where

$r_1$ : residual

$c_1$ : proportionality constant

$\mu_0$ : first sensibility value

5.  $\mu$ : second sensibility value.

9. A heat exchanger abnormality detection device for a heat exchanger (3, 5) exchanging heat between a first fluid (7) in a conduit (6) and a second fluid (8) in a flow path (9), characterized in that the device comprises a first estimator estimating at least one parameter representative of the temperature conditions of the heat exchanger, a first intermediate memory means storing the at least one parameter representative of the temperature conditions of the heat exchanger, a  
15 ~~temperature sensor measuring the second fluid inlet~~  
temperature, a second intermediate memory means storing the second fluid inlet temperature, a second estimator establishing a parameter indicative of expected heat exchange between the heat exchanger (3,  
20 5) and the second fluid (8), a third intermediate memory means storing the parameter indicative of expected heat exchange, a processor establishing an estimated second fluid outlet temperature based on  
25 said at least one parameter representative of the temperature conditions of the heat exchanger, said second fluid inlet temperature, from the first and second intermediate memory means, respectively, and, from the third intermediate memory means, the  
30 parameter indicative of expected heat exchange, and a comparator comparing the estimated second fluid outlet temperature, or a parameter established on basis thereof, with a reference value.

10. A detection device according to claim 9,  
35 characterized in that the detection device further comprises memory means for storing at

least one parameter from the processor.

11. A detection device according to claim 9 or 10, characterized in that the heat exchanger (3, 5) is part of a vapour-compression refrigeration or heat pump system (1) comprising a compressor (2), a condenser (3), an expansion device (4), and an evaporator (5) interconnected by conduits (6) providing a flow circuit for the first fluid (7), said first fluid (7) being a refrigerant.

12. A detection device according to claim 11, characterized in that the heat exchanger (3, 5) is the condenser (3).

13. A detection device according to any of the claims 9-12, characterized in that the second fluid (8) is air.

14. A detection device according to any of the claims 11-13, characterized in that the condenser (3) is part of a refrigerated display cabinet positioned within a building and the condenser (3) is positioned outside the building.

15. Use of a detection device according to any of the claims 9-14, characterized in that the detection device is used for detecting fouling of the heat exchanger (3, 5) and/or detecting insufficient flow of the second fluid (9).

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